# Table of Contents

- Background ................................................................................................................. 3
- Goal of the Study and Report ...................................................................................... 3
- Stakeholder Group ........................................................................................................ 4
- Existing Conditions ...................................................................................................... 5
  - Railroads .................................................................................................................... 6
  - Hazardous Material Traffic ....................................................................................... 6
  - Roadway Network ...................................................................................................... 7
- Potential Alternate Routes ............................................................................................. 8
  - Havana Street ........................................................................................................... 8
  - Peoria Street .............................................................................................................. 8
  - Sable Boulevard ......................................................................................................... 9
  - Chambers Road ......................................................................................................... 9
  - Airport Boulevard ..................................................................................................... 9
  - Tower Road ............................................................................................................... 9
  - Colfax Avenue to/from I-70 East .............................................................................. 10
  - Colfax Avenue to/from I-225 South .......................................................................... 10
- Statute Discussion ........................................................................................................ 10
- Evaluation Criteria ........................................................................................................ 12
  - Phase 1 Evaluation Criteria .................................................................................. 12
  - Phase 2 Evaluation Criteria .................................................................................. 15
- Evaluation Process and Results .................................................................................... 19
  - Phase 1 Evaluation .................................................................................................. 19
  - Phase 1 Results ........................................................................................................ 23
  - Phase 2 Evaluation .................................................................................................. 24
  - Phase 2 Results ........................................................................................................ 28
- Final Alternative Refinement ......................................................................................... 29
- Recommendations ......................................................................................................... 29
  - Preferred Route ....................................................................................................... 29
  - Route Improvements ............................................................................................... 29
  - Appendix A .............................................................................................................. 30
  - Meeting Minutes ..................................................................................................... 30
  - Appendix B .............................................................................................................. 31
  - Alternative Routes .................................................................................................... 31
List of Figures

Figure 1 - Project Area ................................................................. 5
Figure 2 - Phase 1 Evaluation Matrix ........................................... 20
Figure 3 - Phase 2 Evaluation Matrix ........................................... 25
Background
In 2009, the Regional Transportation District (RTD) finished a planning study, an Environmental Impact Study (EIS), which included preliminary design and public open houses for stakeholder review and comment. In 2010, RTD selected a Concessionaire to perform final design and construction for the East Corridor (CU A Line). In April 2016, the CU A Line commuter rail project began operation in which it connects downtown Denver with Denver International Airport. The commuter rail line parallels the existing Union Pacific railroad (UPRR) freight rail line along Smith Road in portions of Denver and Aurora, Colorado. In the Aurora segment of the corridor, Smith Road and Chambers Road provide access to numerous trucking companies, transload facilities, and other significant truck traffic generators. As the state representative for the trucking industry, the Colorado Motor Carriers Association (CMCA) has expressed concerns about how truck traffic flows across the shared RTD/UPRR rail corridor at Chambers Road. Of particular concern are trucks carrying hazardous materials that could pose substantial risks if an incident with a train were to occur. These trucks are common in the Smith Road / Chambers Road area as one of the largest fuel transload facilities in Colorado is located about ¼ mile from the intersection.

In 2015, CMCA reached out to RTD to convey their concerns about hazardous materials transport along the CU A Line. Discussions about these issues have been held regularly since the initial meeting in 2015. Stakeholders have included RTD and their concessionaire DTP, CMCA, the Colorado State Patrol (CSP), the Federal Railroad Administration (FRA), the Colorado Public Utilities Commission (PUC), various departments within the City of Aurora, and other interested agencies. It was found that CMCA and RTD had differing understandings of the nature of the issue, the regulatory framework for hazardous materials transport, and the effects that the CU A Line commuter rail project could have on the local trucking industry.

From August 9, 2017 through November 29, 2017, a series of four stakeholder meetings took place to have on-going discussions to address these concerns and to evaluate potential alternative truck routes with all the stakeholders. The stakeholder meeting discussion points and data material handouts were recorded in meeting minutes and distributed to the stakeholders. At the conclusion of these stakeholder meetings, the study team was tasked to prepare a comprehensive draft report for stakeholder distribution to outline data, findings and discussions that were presented and occurred through the course of the four meetings.

The following is a draft report prepared by the study team in conclusion of the last stakeholder meeting held on November 29, 2017 that outlines the collaborative effort with all the stakeholders through the series of stakeholder meetings.

Goal of the Study and Report
The goal of the study and the ongoing stakeholder discussions was to identify safe and feasible alternative routes for hazardous materials transportation that meets operational
needs, regulatory criteria, and state statutes for hazardous materials transport in the project area. Options considered during stakeholder study sessions with stakeholders included grade separation, new or relocated roadways, and alternate routes. Given the need to address current conditions, this study evaluates alternate routes that generally can be implemented quickly and with reasonable costs and concluding with a preferred alternate route identified by the stakeholders at the stakeholder study sessions. It also considers improvements that may be required to be implemented to the preferred alternate route for the hazardous material trucks to utilize it.

**Stakeholder Group**

In support of these discussions, a stakeholder group was assembled to reflect the different perspectives on this issue. The group consisted of the following entities:

- Federal Railroad Administration
- Federal Transit Administration
- Federal Motor Carrier Safety Administration
- Colorado Department of Transportation
- Colorado State Patrol
- Colorado Public Utilities Commission
- Regional Transportation District
- City of Aurora:
  - Aurora Department of Public Works
  - Aurora Fire Department
  - Aurora Police Department
- Colorado Motor Carriers Association
- Colorado Wyoming Petroleum Marketers Association
- Local Carriers:
  - Hill Petroleum
  - Offen Petroleum
  - R and L Carriers
  - Dixon Brothers, Inc.
  - Wodek Systems
  - YRC

Four stakeholder meetings were held at the CMCA Training Facility just north of downtown Denver. Minutes of these meetings are attached as Appendix A.

**Summary of discussion points from each stakeholder meeting:**

Meeting #1 – Overview of study concept and approach; selection of eight potential alternate routes to move forward in the study; discussion of study evaluation criteria.

Meeting #2 – Phase 1 and 2 evaluation criteria and list discussion; discussion and selection of eight routes (Chambers, Havana, Peoria, Sable, Airport, Tower, Colfax to I-70, and Colfax to I-225) for Phase 1 analysis; discussion of Phase 1 results on eight
potential alternate routes when evaluation criteria applied; three alternate routes selected by stakeholders to move into Phase 2 evaluation.

Meeting #3 – Selection of Chambers, Airport and Tower as three alternate routes for Phase 2 evaluation; stakeholders review and discussion of Phase 2 analysis and criteria for the three alternate routes.

Meeting #4 – Stakeholder discussion and comments on Phase 2 criteria and evaluation matrix; stakeholder consideration of Airport Boulevard as probably the most appropriate alternate route; study team to develop draft report with inclusion of information presented throughout the series of stakeholder meetings and to identify a preferred route alternate.

**Existing Conditions**
The evaluation of alternate routes must take into account the roadway network, the railroad network, and the truck traffic (including hazardous material traffic) interacting with these elements. This section of the report provides a brief overview of these components as they are the basis for subsequent analyses. Refer to Figure 1.

![Figure 1 - Project Area](image)

Page | 5
**Railroads**
The original rail line in this area is an east-west UPRR main line that connects Denver to Salina, Kansas. This line currently carries 8 to 10 freight trains per day on two tracks at speeds of up to 49 mph. The CU A Line is a double track commuter railroad that connects downtown Denver to Denver International Airport with maximum operating speeds of up to 79 mph. In the project area, it has been constructed south of the UPRR line to east of Chambers Road. At this point, it becomes a single track line that climbs onto a structure and turns north over Airport Boulevard toward Peña Boulevard and the airport. Commuter trains operate every fifteen minutes in each direction for the majority of the day, resulting in 7½ minute average headways.

The Chambers Road at-grade crossing was expanded and improved when the CU A Line was constructed. The commuter rail tracks were built south of the UPRR tracks, effectively reducing the space between the railroad and the adjacent Smith Road / Chambers Road intersection from about 110 feet to about 25 feet. The UPRR crossing had active warning devices prior to the RTD project. These devices were upgraded to accommodate the commuter rail line as part of the RTD effort. Flashers, bells, and crossing gates have been installed on both the northbound and southbound approaches to the crossing, and exit gates have also been installed on the southbound side of the crossing. As part of the crossing reconstruction, the adjacent Smith Road / Chambers Road intersection and traffic signal were reconstructed, including upgrading the previous interconnect between the railroad crossing and the traffic signal. The intersection and crossing were both designed to accommodate turning movements for large trucks given the known trucking business in the area.

**Hazardous Material Traffic**
The segment of Smith Road between the I-225 overpass and Airport Boulevard provides access for five significant trucking companies – YRC Freight, Magellan Midstream Partners, Worldwide Rental Services, Estes Express Lines, and R&L Carriers. YRC Freight, Estes Express Lines, and R&L Carriers provide LTL and truckload services for a wide range of customers. These services may include cargo that qualifies as hazardous materials on the trucks using their facilities along Smith Road. Worldwide Rental Services provides earthmoving, pipeline, and other heavy equipment rentals and sales. Although this equipment is not by itself hazardous, equipment fuel tanks and the sheer size of the heavy equipment makes it a safety concern for the at-grade crossings under study.

Magellan Midstream Partners is one of the biggest fuel loading facilities in the country in terms of hazardous materials trucks. The facility can load 12-16 tank trucks per hour, taking about 15-20 minutes to load each truck in one of four bays. Overall, the facility averages 400 tanker round trips per day (800 combined movements). There are also fuel additives and other chemicals delivered to the Magellan facility each day. The facility is capable of being expanded to six bays, essentially adding 50% to the loading capabilities of the site.

Given these shippers plus other hazardous materials trucks in the general traffic stream, the Chambers Road crossing serves 800-1000 hazardous materials trucks per day at
peak times of the year. It is possible to have 40 or more trucks crossing the at-grade Chambers Road crossing during the peak trucking periods each day.

**Roadway Network**
The alternate route evaluation does not have a defined study area. Previous alternate route discussions included Havana, Peoria, Sable, Airport, Tower, and Colfax. Several concerns were raised with specific routes during previous meetings, including the new R Line light rail at-grade crossing at the 33rd Street / Peoria Street intersection. These issues were brought forward into this study as part of the route evaluation process.

As noted above, the study goal is to provide a reasonable, safe connection between the hazardous materials shippers along Smith Road and the nearby designated hazardous material routes in the area (generally I-70 and I-225). Again, it should be noted that Chambers Road, in and of itself, is not a hazardous materials route. However, it carries much of the Smith Road hazardous material traffic as it is the shortest route between these facilities and I-70.

To identify a reasonable study area, several interchanges along I-70 east and west of Chambers and along I-225 south of I-70 were briefly explored. It was determined that routes that replaced more than three or four miles of interstate travel with arterial travel would not be feasible. This is because uncongested interstate travel occurs at speeds of 55mph or more, while uncongested arterial travel rarely averages more than 40mph. This speed differential over three to four miles equates to five minutes or more in added travel time, which is generally unreasonable for commercial truck trips.

Given the three to four mile radius from the Smith Road / Chambers Road area, the study team defined a number of routes for the alternatives evaluation. They are:
- Havana Street
- Peoria Street
- Sable Boulevard
- Chambers Road
- Airport Boulevard
- Tower Road
- Colfax Avenue to/from I-70 East
- Colfax Avenue to/from I-225 South

Details about each route are presented later in this report.

Smith Road serves to connect the various trucking facilities and carry trucks to and from the potential alternate routes. It is generally a two-lane arterial in the two-mile segment centered on Chambers Road (between the I-225 overpass and Airport Boulevard). Turn lanes are provided at key intersections. Smith Road is bounded on the north by the rail corridor, so there are no public access points on the north side of the street. On the south side of the street, about two thirds of the parcels are occupied with industrial land uses. Trucking companies in this area include YRC Freight (just east of Sable Boulevard), Estes Express Lines (about half way between Chambers Road and Laredo Street), and R+L Carriers (just west of Airport Boulevard). This segment also serves
Magellan Midstream Partners (fuel transload facility, about half way between Sable Boulevard and Chambers Road) and Worldwide Rental Services (heavy equipment rental, just west of Chambers Road). These facilities are shown on Figure 1. Refer to the discussion of hazardous material traffic for more information regarding several of these facilities. The remaining commercial parcels are currently vacant, but development in this area is continuing, with businesses such as Specialty Wood Products (east of Laredo Street) moving into the corridor.

Potential Alternate Routes
The study team reviewed each of the potential routes and identified key features that relate to truck travel and hazardous materials routing. The results of this process for each route are described in more detail below. Figures representing each route are included in Appendix B.

The routes described below were evaluated using evaluation criteria developed by the stakeholder group, as describes later in the report. In order to accurately evaluate the routes, it was necessary to develop endpoints for the hazardous truck trips of concern. Since the Magellan facility provides the majority of the hazardous materials shipments on a daily basis, it is assumed to be one endpoint. For trips going generally east, I-70 at the Colfax interchange was assumed to be the easterly endpoint. For trips going generally south, I-225 at the Colfax interchange was assumed to be the southerly endpoint. For trips going north and/or west, I-70 at the I-270 interchange was assumed to be the westerly endpoint.

Havana Street
The east end of the Havana Street route would be the Magellan site. The west end would be the I-70 / Havana interchange. To connect these points, trucks would drive along Smith Road between Magellan and Peoria Street, where they would connect to 33rd Street (one block south) via the Peoria Street frontage Road (westbound) or Quentin Street (eastbound). This connection would require trucks to use the existing roundabout at the 33rd Street / Peoria Frontage Road intersection. The 33rd Street Peoria intersection is signalized, and includes an at-grade crossing of RTD's R Line LRT tracks. On the west side of Peoria, trucks would use Moline Street to connect between 33rd Street and Smith Road, and Smith Road would provide a connection between Moline and Havana Street. Trucks would connect between Smith Road and the I-70 Havana Street interchange along Havana, crossing the CU A Line commuter rail tracks and the UPRR freight rail tracks at grade on Havana. The I-70 interchange at Havana Street is a folded diamond, with all ramps connecting to Havana Street on the west side of the arterial. Refer to Figure A1 - Havana Street Route.

Peoria Street
The east end of the Peoria Street route would be the Magellan site. The west end would be the I-70 / Peoria interchange. To connect these points, trucks would drive along Smith Road between Magellan and Peoria Street, where they would connect to 33rd Street (one block south) via the Peoria Street frontage Road (westbound) or Quentin Street (eastbound). This connection would require trucks to use the existing
roundabout at the 33rd Street / Peoria Frontage Road intersection. The 33rd Street / Peoria intersection is signalized, and would provide turning movements between Peoria Street and 33rd Street. Trucks would connect between 33rd Street and the I-70 / Peoria Street interchange along Peoria, crossing the CU A Line commuter rail tracks and the UPRR freight rail tracks on the Peoria grade separation structure. The I-70 interchange at Peoria Street is a typical diamond. Refer to Figure A2 – Peoria Street Route.

**Sable Boulevard**
This route is relatively local to the shippers along Smith Road, as it uses the Chambers Road interchange to access I-70, but uses Sable to cross the CU A Line and UPRR tracks. The south end of the Sable Boulevard route would be the Magellan site. The north end would be the I-70 / Chambers interchange. To connect these points, trucks would drive along Smith Road between Magellan and Sable Boulevard. The Sable Boulevard / Smith Road intersection is signalized, and would provide turning movements between Smith Road and Sable Boulevard. Trucks would connect between Smith Road and 35th Street along Sable, crossing the CU A Line commuter rail tracks and the UPRR freight rail tracks at grade. Trucks would then connect between Sable Boulevard and Chambers Road along 35th Street using a stop-controlled intersection at Sable / 35th and a signalized intersection at Chambers / 35th. The final connection between 35th Street and the Chambers Road / I-70 interchange would occur along Chambers Road. The I-70 interchange at Chambers Road is a typical diamond, with braided ramps with the Pena Boulevard interchange to the east. Refer to Figure A3 – Sable Boulevard Route.

**Chambers Road**
This is the current route that most Smith Road trucks use, as it is the shortest / most direct connection between Smith Road and the Chambers interchange at I-70. The Chambers Road / Smith Road intersection is signalized, and provides turning movements between Smith Road and Chambers Road. The I-70 interchange at Chambers Road is a typical diamond, with braided ramps with the Pena Boulevard interchange to the east. Refer to Figure A4 – Chambers Road Route.

**Airport Boulevard**
The west end of the Airport Boulevard route would be the Magellan site. The east end would be the I-70 / Airport Boulevard interchange. To connect these points, trucks would drive along Smith Road between Magellan and Airport Boulevard, passing through the Chambers Road / Smith Road intersection. The Airport Boulevard / Smith Road intersection is signalized, and would provide turning movements between Smith Road and Airport Boulevard. Trucks would connect between Smith Road and I-70 along Airport, crossing the UPRR freight rail tracks at grade and passing under the CU A Line commuter rail tracks at approximately 30th Avenue. The I-70 interchange at Airport Boulevard is a partial cloverleaf interchange, with loop ramps in the northwest and southeast quadrants. Refer to Figure A5 – Airport Boulevard Route.

**Tower Road**
The west end of the Tower Road route would be the Magellan site. The east end would be the I-70 / Tower Road interchange. To connect these points, trucks would drive
along Smith Road between Magellan and Tower Road, passing through the Chambers Road / Smith Road and Airport Boulevard / Smith Road intersection. The Tower Road / Smith Road intersection is signalized, and would provide turning movements between Smith Road and Tower Road. Trucks would connect between Smith Road and I-70 along Tower, crossing the UPRR freight rail tracks at grade. There is no CU A Line crossing on this route. The I-70 interchange at Tower Road is a typical diamond. Refer to Figure A6 – Airport Boulevard Route.

**Colfax Avenue to/from I-70 East**
The west end of the Colfax Avenue to/from I-70 East route would be the Magellan site. The east end would be the I-70 / Colfax Avenue interchange. To connect these points, trucks would drive along Smith Road between Magellan and Chambers Road. They would use Chambers Road to connect between Smith Road and Colfax Avenue, and they would then use Colfax Avenue to connect between Chambers Road and the Colfax / I-70 interchange. The I-70 interchange at Colfax Avenue is a directional interchange that precludes the eastbound Colfax to westbound I-70 movement. Hence, westbound trips would have to go east on I-70 to E-470 (about 1 mile) and turn around at the E-470 diamond interchange. Refer to Figure A7 – Colfax Avenue to I-70 East Route.

**Colfax Avenue to/from I-225 South**
The north end of the Colfax Avenue to/from I-225 south route would be the Magellan site. The south end would be the I-225 / Colfax Avenue interchange. To connect these points, trucks would drive along Smith Road between Magellan and Chambers Road. They would use Chambers Road to connect between Smith Road and Colfax Avenue, and they would then use Colfax Avenue to connect between Chambers Road and the Colfax / I-225 interchange. The I-225 interchange at Colfax Avenue is a double diamond interchange that also allows connections to and from 17th Street to I-225. Refer to Figure A8 – Colfax Avenue to I-70 East Route.

**Statute Discussion**
Hazardous material trucks are regulated by both Federal and State statute. This report does not delve into the many statutes surrounding hazardous materials transport. However, an overview of issues surrounding hazardous materials trucking over at-grade rail crossings is presented here, as it informs the Alternate Route evaluation process.

Under current Federal regulations, trucks carrying hazardous materials have to stop before an at-grade railroad crossing and visually verify it is safe to cross before proceeding\(^1\). This requirement is also presented in Colorado state statute\(^2\). The

\(^1\) Code of Federal Regulations, Title 49: Transportation, §392.10  Railroad grade crossings: stopping required states:

(a) Except as provided in paragraph (b) of this section, the driver of a commercial motor vehicle specified in paragraphs (a) (1) through (6) of this section shall not cross a railroad track or tracks at grade unless he/she first: Stops the commercial motor vehicle within 50 feet of, and not closer than 15 feet to, the tracks; thereafter listens and looks in each direction along the tracks for an approaching train; and ascertains that no train is approaching. When it is safe to do so, the driver may drive the commercial motor vehicle
requirement raises concerns at the Chambers Road crossing because there is inadequate distance between the CU A Line tracks and the Chambers Road / Smith Road intersection for a hazardous materials truck to stop approaching the tracks (as required by statute) without blocking lanes in the roadway intersection.

Hazardous truck routing is not regulated at the Federal level. However, most states (including Colorado) have statewide regulations regarding hazardous materials routing, and some municipalities have similar regulations. Aurora does not directly regulate hazardous materials routing, so the Colorado state statute applies for this study. The Colorado State Patrol approves hazardous materials routes, with support from the Colorado Department of Transportation. In the project area, I-70 and I-225 are designated routes. Chambers Road (and other arterials in the project area) are not designated hazardous materials routes.

Under current Colorado hazardous material routing statutes, "the motor vehicle shall remain on authorized routes whenever possible and shall minimize the distance traveled on restricted routes." Given this statutory language, hazardous materials trucks have historically used Chambers Road to reach the Magellan facility and other facilities along this segment of Smith Road. However, statute also provides that trucks can deviate from the 'shortest' route if "such action is so required by emergency conditions which would make continued use of authorized routes unsafe". This provides some flexibility for hazardous materials rerouting due to safety concerns.

The CMCA has expressed concerns that if trucks use a route other than Chambers Road, their drivers may be subject to fines and added liability. However, the CMCA understands the current lack of an arterial hazardous materials route structure in the study area. Hence, they are not looking for a formally designated hazmat route between I-70 and the Smith Road corridor. The City of Aurora has agreed that they do not wish to formally designate route(s) within the City. The stakeholder group agreed that this study should result in a clearer definition of what constitutes reasonable local pickup and delivery in the study area based on existing statues.

2 Refer to Colorado Revised Statutes 42-4-707: Certain vehicles must stop at railroad grade crossings.
3 Colorado Revised Statutes 42-20-305.(1): Deviation from authorized route – penalty:
No person shall transport hazardous materials by motor vehicle contrary to any route designation approved by the patrol pursuant to this part 3 unless such action is necessary to service a motor vehicle or to make a local pickup or delivery of hazardous materials or unless such action is so required by emergency conditions which would make continued use of authorized routes unsafe or by the closure of an authorized route pursuant to section 42-20-304, and, in such circumstances, the motor vehicle shall remain on authorized routes whenever possible and shall minimize the distance traveled on restricted routes. A person transporting hazardous materials by motor vehicle may make successive local pickups and deliveries without returning to the authorized route between each pickup or delivery when such return would be unreasonable. A person transporting hazardous materials shall not utilize residential streets unless there is no other reasonable route available to reach the destination.
Evaluation Criteria
A series of evaluation criteria were developed to allow for comparisons between the various routes described above. These criteria were initially proposed by the study team, and significant input from the stakeholder team was provided prior to the initial route evaluations. This input continued through the evaluation process. Some criteria were added, modified, or dropped over the course of the study to reflect stakeholder input and reflect available data. Another key piece of stakeholder input was the separation of the evaluation process into two steps. The initial evaluation considered all of the identified routes and used more general criteria, while the final evaluation applied more detailed criteria to a shorter list of routes selected based on the initial evaluation.

A key feature of the evaluation criteria was directionality. For some measures, trips inbound to the facilities along Smith Road would have different experiences than trips outbound from the facilities along Smith Road. For example, an outbound trip may require a left turn at a particular intersection, while an inbound trip would require a right turn at that same intersection. For those criteria where directionality makes a difference, this is noted in the description.

Both the Phase 1 and the Phase 2 evaluation criteria were separated into five broad categories. These were:

- Railroad Interaction – How do hazardous materials vehicles interface with the railroads along each route?
- Roadway Operations – How do hazardous materials vehicles interface with the roadways between the freeway and their origin / destination?
- Freeway operations – How do hazardous materials vehicles interface with the freeway (designated hazardous materials route)?
- Communities – How do hazardous materials vehicles interface with the neighborhoods along each route?
- Jurisdictions / Agencies – How does each hazardous materials route fit within local, state, and federal regulations?

For continuity, the Phase 1 criteria were included in the Phase 2 evaluation for the shortlisted routes. Both the Phase 1 and Phase 2 criteria are described further below.

Phase 1 Evaluation Criteria
The following criteria were used in the Phase 1 screening:
- Railroad Interaction
  - Number of at-grade CRT rail crossings and number of CRT tracks – This is a simple count of the number of commuter rail at-grade rail crossings along the route, and the total number of tracks that would be crossed along the route.
  - Number of at-grade freight rail crossings and number of freight tracks – This is a simple count of the number of freight rail at-grade rail crossings along the route, and the total number of tracks that would be crossed along the route.
  - Total rail interactions (added criterion) – This was added by the stakeholder group to summarize the CRT and freight interactions. It is a
simple sum of the number of at-grade CRT rail crossings, the number of CRT tracks, the number of at-grade freight rail crossings, and the number of freight tracks. The lower the sum, the better the ranking.

- Storage distance between tracks – For at-grade crossings where two sets of tracks are farther apart than the typical 15 feet to 25 feet, this criterion provides the distance between tracks. If this distance is significant, drivers may attempt to stop between the two sets of tracks, within the crossing. Crossings with no storage distance between tracks were ranked best.

- Storage distance between tracks and adjacent signal (where adjacent signal exists) – For locations where a traffic signal is located within 200 feet of an at-grade crossing, the distance between the signal and the crossing is provided. Crossings where there is no adjacent signal were ranked best.

• Roadway Operations
  - Key traffic signals (changed to “traffic signals”) – This is a simple count of the number of traffic signals along each route. Routes with fewer signals were ranked better.
  - Roundabouts – This is a simple count of the number of roundabouts along each route. Routes with fewer roundabouts were ranked better.
  - Pedestrian Facilities (added criterion) – The stakeholder group expressed concerns over the interaction between trucks and multimodal users along the routes, and this criterion was developed to reflect these concerns. Each route was reviewed to determine if the majority of the route had sidewalks along both sides of the route, along one side of the route, or no sidewalks. Routes with sidewalks along both sides were ranked better.
  - Adequate lane widths – This criterion was moved to Phase 2.
  - Adequate turning movements / design vehicle – This criterion was moved to Phase 2.
  - Vertical alignment (qualitative) – Are there significant grades along the arterial portion of the route that would affect truck operations? Routes without significant grades were ranked better.
  - Travel distance – This criterion was the subject of significant stakeholder discussion. The final measure is the sum of three distances along each route – the distance between Chambers Road / Smith Road and the I-70 / I-270 interchange (west), the distance between Chambers Road / Smith Road and the I-70 / Colfax interchange (east), and the distance between Chambers Road / Smith Road and the I-225 / Colfax interchange (south). Routes with shorter total distances were ranked better.

• Freeway operations
  - Adequate merge distance once on interstate – This criterion is for outbound trips. It measures how easy it would be for vehicles leaving the Chambers Road / Smith Road area to merge onto the freeway. Merge

---

4 This value is based on Section 8C.08 of the Federal Manual on Uniform Traffic Control Devices (MUTCD), which recommends traffic signal interconnection when a traffic signal is within 200 feet of an at-grade crossing.
areas with long merge lengths, braided ramps (eliminating weaving areas), or long weaving areas were ranked better.

- Interchange configuration – this criterion describes the general interchange type where the arterial portion of the route meets the Interstate portion of the route. Although it informs the process, no particular interchange type was deemed to be better or worse than other types. Hence, it was not ranked as a discriminator in the process.

- Vertical and horizontal alignments (qualitative) - Are there significant grades or curves along the freeway portion of the route that would affect truck operations? Routes without these features were ranked better.

- Communities
  - Adjacent land use (qualitative, parcels abutting corridor) – This measure reflects existing development that could be affected by hazardous material truck trips along each route. More industrial land uses along a route were ranked as better.
  - Future land use (added criterion) – This measure was added by the stakeholder group to reflect planned development that could be affected by nearby hazardous material truck trips. Fewer new developments or redevelopments along a route were ranked as better.
  - Population around the route – This criterion reflects a qualitative measure of the residential land use along each route, acknowledging that a hazardous materials incident closer to residential populations may have larger impacts. Routes with fewer adjacent residential land uses were ranked better.
  - Public perspective – This qualitative measure reflects communities that have cohesive groups that could oppose hazardous truck trips along a route, such as a Business Improvement District (BID) or an HOA (Homeowners Association). Routes without known community groups were ranked better.

- Jurisdictions / Agencies
  - Consistent with applicable state and federal laws and regulations – This criterion was expanded by the stakeholder group as the study progressed. In the final Phase 1 evaluation, it consists of three sub-measures:
    - Stop before the tracks – Would a hazardous materials truck have to stop in an intersection to comply with regulations requiring a stop before entering a crossing? For locations where a stop in an intersection would be required, the storage distance criterion was reviewed to determine what the impact to the intersection might be. Locations with no intersection conflicts were ranked better.
    - Route – This criterion reflects jurisdictional issues with each route. Generally, Aurora allows trucks to use City arterials for travel, and requires that trucks minimizer travel on collectors and residential streets. For routes in Aurora, this criteria was shown as 'on arterial' or 'not on arterial', with the 'on arterial' routes being ranked better. For routes where the arterial portion of the route crosses two
jurisdictions, the arterial truck routing was not evaluate for the second jurisdiction, and the route was not given a positive ranking.

- Less than 1 mile out of direction – To reflect the statutory requirement to “minimize the distance traveled” while performing local pickup and delivery, routes that allow hazardous materials trucks to travel less than one additional mile out of direction between I-70 and the Chambers Road / Smith Road intersection were ranked better.

- Compiled – This criterion is a summary of the three regulatory criteria above, and represents the total number of ‘better’ rankings for each route.
  
  o Emergency (Hazardous Material) response capabilities – This criterion was evaluated by the stakeholder group with direct input from the City of Aurora Fire Department. Their hazardous materials response unit is housed at a central location, and each route was evaluated to subjectively determine how easy it would be for the hazardous materials team to respond to a hazardous material incident along the route. Routes with comparatively easy response were ranked better. Routes that cross into another jurisdiction were ranked poorly as the two jurisdictions would have differing response times and capabilities along the route.

  o Stays within the jurisdiction – The arterial portion of each route was evaluated to determine if it remains within Aurora (where the Chambers Road / Smith Road hazardous materials facilities are located), or if the route enters a second jurisdiction. Routes that remain in Aurora were ranked better, as coordination across jurisdictional lines would be minimized.

The results from the application of these criteria were used to determine the routes that would be further evaluated using the Phase 2 evaluation criteria.

**Phase 2 Evaluation Criteria**

The following criteria were used in the Phase 2 screening:

- Railroad Interaction – These criteria were maintained from the Phase 1 screening with no changes.

- Roadway Operations – The criteria from the Phase 1 screening were maintained, plus they following criteria were evaluated:
  
  o **Adequate lane widths (criterion from Phase 1)** – The study team reviewed the arterial portion of the shortlisted routes to determine average lane widths along each route. Based on AASHTO guidance, 12-foot lane widths are desirable, so facilities with 12-foot lane widths (or wider) were ranked better.

---

2 Op. Cit. Colorado Revised Statutes 42-20-305 (1)

Adequate turning movements / design vehicle (criterion from Phase 1) – The arterial portion of each route was evaluated to determine if typical hazardous materials tractor-trailer combinations could make the various turns along the route. Further, curbs and median islands were reviewed for damage from tractor-trailer over-tracking, and stakeholders from the trucking industry were asked about problem areas. Routes that provide adequate turning movements were ranked better.

Does not unreasonably burden local roads – This criterion was removed from the evaluation as consensus could not be reached among the stakeholders about a definition for the term ‘burden’.

Overall crash history at intersections – Aurora Public Works provided Level of Safety Service (LOSS) data for the signalized intersections along each route. The study team evaluated these data and scored each intersection on a scale of 1 to 4 based on the LOSS results. An intersection scored a 1 if the LOSS was below the 20th percentile, a 2 if it was between the 20th percentile and the median, a 3 if it was between the median and the 80th percentile, and a 4 if it was above the 80th percentile. The resulting intersection scores were averaged along each route base on the intersections that the route passes through. Routes with lower scores ranked better.

Commercial vehicle crash history at intersections – This criterion was modified based on limited data. The final criterion reflects the total number of commercial vehicle crashes on the arterial portion of each route based on Aurora Fire Department response data and related accident reports reviewed by Aurora Public Works. Routes with lower scores ranked better.

Hazardous Material crash history at intersections – This criterion was removed from the evaluation due to lack of available hazardous material crash data.

Protected, permissive, protected/permissive left turn movement – Because the left turns only occur in the outbound direction along the designated routes, this is an outbound-only evaluation. This criterion was split to accurately reflect each left turn type. Protected left turns are those that occur with a green arrow and no opposing traffic conflicts with the turning movement. Permissive left runs are those that occur with either no turn arrow or a flashing yellow arrow, and drivers must decide when it is safe to turn across oncoming traffic. Protected-permissive turns are a scenario where a green left run arrow is provided during some portion of the left turn operation, and a permissive left turn is provided for the remainder of the left turn operation. For trucks, permissive left turns can be difficult because trucks accelerate more slowly than cars. Therefore, routes with protected left turns are ranked better.

Adequate storage distances – This criterion is also related to outbound left turns. Where left turns are required, the addition of hazardous materials trucks to the left run lane could cause backups (queues) into through lanes. Existing field conditions were observed during peak periods. If the
existing left turn lane was observed to fill up without potential additional hazardous materials truck traffic, the location was flagged as having inadequate storage distance.

- **Queueing** – Although an operational analysis to determine queue lengths could not be performed due to lack of intersection traffic volume data, the general change in hazardous material truck volumes have been noted for this evaluation criterion. No ranking has been provided.

- **Pavement condition** – A visual inspection of the arterial pavement condition was conducted for this criterion. Routes with better pavement condition were ranked better.

- **Road capacity** – This criterion was split into existing and future conditions to provide a more robust evaluation.
  - The existing daily roadway link volume (average daily traffic or ADT) on the busiest section of the route was obtained from online sources. This volume was divided by 10 to reflect peak hour conditions (10% of the daily volume). The resulting peak hour volume was divided by the available roadway capacity (1900 passenger cars per hour per lane\(^7\)) to determine a rough measure of operational performance. If the result was under 1.0 (in other words, the roadway is under capacity), the route was ranked better than if the roadway was found to be over capacity.
  - For this measure, future conditions were defined as existing volume plus 1000 additional daily hazardous materials trucks to reflect possible expansions of Magellan and other facilities along Smith Road. The resulting total volume was divided by 10 to reflect peak hour conditions and by the available roadway capacity (1900 passenger cars per hour per lane) to determine a rough measure of operational performance. If the result was under 1.0 (in other words, the roadway is under capacity), the route was ranked better than if the roadway was found to be over capacity.

- **Heavy Vehicle capacity** - This criterion was also split into two measures to provide a more robust evaluation.
  - The study team performed a future conditions analysis assuming that 1000 new hazardous materials vehicles would be added to the system to meet the growing demand of hazardous material transport.
  - If the result was under 1.0 (in other words, the roadway is under capacity), the route was ranked better than if the roadway was found to be over capacity.

- **Improvements required** – This is not a criterion, but a place to record the improvements that could be required to address concerns identified during the screening above. More detail for these improvements is provided in the final recommendations.

---

• Conceptual Costs (added criterion) – This criterion was added to reflect the costs of the improvements identified in the previous bullet.

• Freeway operations – The criteria from the Phase 1 screening were maintained, plus the following criteria were evaluated:
  o Does not unreasonably burden interstate – This criterion was removed from the evaluation as consensus could not be reached among the stakeholders about a definition for the term 'burden'.
  o Pavement condition – A visual inspection of the freeway ramp pavement condition was conducted for this criterion. The evaluation did not provide much difference in the condition of the pavement. No ranking has been provided.
  o Interstate capacity - This criterion was split into existing and future conditions to provide a more robust evaluation.
    ▪ The existing daily freeway link volume (average daily traffic or ADT) were obtained from CDOT's OTIS site. This volume was divided by 10 to reflect peak hour conditions (10% of the daily volume). The resulting peak hour volume was divided by the available roadway capacity (1900 passenger cars per hour per lane) to determine a rough measure of operational performance. If the result was under 1.0 (in other words, the roadway is under capacity), the route was ranked better than if the roadway was found to be over capacity.
    ▪ For this measure, future conditions were defined as existing volume plus 1000 additional daily hazardous materials trucks to reflect possible expansions of Magellan and other facilities along Smith Road. The resulting total volume was divided by 10 to reflect peak hour conditions and by the available roadway capacity (1900 passenger cars per hour per lane) to determine a rough measure of operational performance. If the result was under 1.0 (in other words, the roadway is under capacity), the route was ranked better than if the roadway was found to be over capacity.

• Heavy Vehicle capacity - This criterion was also split into two measures to provide a more robust evaluation.
  ▪ The study team performed a future conditions analysis assuming that 1000 new hazardous materials vehicles would be added to the system to meet the growing demand of hazardous material transport.
  ▪ If the result was under 1.0 (in other words, the roadway is under capacity), the route was ranked better than if the roadway was found to be over capacity.

• Improvements required - This is not a criterion, but a place to record the improvements that could be required to address concerns identified during the screening above. More detail for these improvements is provided in the final recommendations.

---

- **Conceptual Costs (added criterion)** - This criterion was added to reflect the costs of the improvements identified in the previous bullet.

- **Communities** – The criteria from the Phase 1 screening were maintained, plus they following criteria were evaluated:
  - The criteria from the Phase 1 screening were maintained, plus they following criteria were evaluated:
  - Sensitive areas - Sensitive areas are schools, lakes, rivers, etc. that have environmentally and population based safety concerns. These generally increase as you move east in the study area. Routes with the least amount of impacts were rated as “best”.

- **Jurisdictions / Agencies** – These criteria were maintained from the Phase 1 screening with no changes.

The results from the application of these criteria were used to determine the preferred alternate route identified in this study.

**Evaluation Process and Results**

The routes identified above were evaluated using the evaluation criteria in a two-step process. The Phase 1 evaluation resulted in a short list of routes. The Phase 2 evaluation resulted in a preferred alternative. Each of these efforts is described below.

**Phase 1 Evaluation**

For each criterion, the study team selected the 'best' result and highlighted those results in the matrix. Refer to Figure 2 for a summary of the material discussed below.
<table>
<thead>
<tr>
<th>Havana Street</th>
<th>Perla Street</th>
<th>Sable Boulevard</th>
<th>Chambers Road</th>
<th>Airport Boulevard</th>
<th>Tower Road</th>
<th>Cellfax Avenue EB</th>
<th>Cellfax Avenue WB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of at-grade CRT rail crossings &amp; number of CRT tracks</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Number of at-grade LRT crossings &amp; number of LRT tracks</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of at-grade freight rail crossings &amp; number of freight tracks</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total rail intersections</td>
<td>13</td>
<td>0</td>
<td>14</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Storage distance between tracks</td>
<td>40'</td>
<td>-</td>
<td>-</td>
<td>35'</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Storage distance between tracks and adjacent signal (outbound only)</td>
<td>20'</td>
<td>-</td>
<td>-</td>
<td>20'</td>
<td>-</td>
<td>-</td>
<td>10'</td>
</tr>
<tr>
<td>Traffic signals</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Roundabouts</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pedestrian facilities</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Vertical alignment</td>
<td>easy</td>
<td>difficult</td>
<td>easy</td>
<td>easy</td>
<td>moderate</td>
<td>easy</td>
<td>easy</td>
</tr>
<tr>
<td>Travel distance</td>
<td>5.1 miles</td>
<td>4.7 miles</td>
<td>5.5 miles</td>
<td>4.8 miles</td>
<td>6.9 miles</td>
<td>8.5 miles</td>
<td>15.9 miles</td>
</tr>
<tr>
<td>To-179 and 1-270</td>
<td>11.8 miles</td>
<td>9.7 miles</td>
<td>6.5 miles</td>
<td>5.8 miles</td>
<td>5.5 miles</td>
<td>5.2 miles</td>
<td>5.9 miles</td>
</tr>
<tr>
<td>To-1-1-270 and Cofer</td>
<td>8.0 miles</td>
<td>6.6 miles</td>
<td>4.8 miles</td>
<td>4.1 miles</td>
<td>6.3 miles</td>
<td>7.9 miles</td>
<td>15.6 miles</td>
</tr>
<tr>
<td>Total</td>
<td>24.9 miles</td>
<td>20.3 miles</td>
<td>16.8 miles</td>
<td>14.7 miles</td>
<td>10.7 miles</td>
<td>21.6 miles</td>
<td>37.4 miles</td>
</tr>
<tr>
<td>Adequate merging distance to enter interstate (outbound only)</td>
<td>difficult</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
<td>moderate</td>
<td>easy</td>
<td>easy</td>
</tr>
<tr>
<td>Interchange configuration</td>
<td>folded diamond</td>
<td>diamond</td>
<td>diamond</td>
<td>diamond</td>
<td>partial cloverleaf</td>
<td>diamond</td>
<td>direct ramp</td>
</tr>
<tr>
<td>Vertical and horizontal alignment</td>
<td>moderate</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
</tr>
<tr>
<td>Adjacent land use</td>
<td>Industrial/residential</td>
<td>Industrial/residential</td>
<td>Industrial</td>
<td>Industrial</td>
<td>Industrial</td>
<td>Industrial</td>
<td>Industrial/residential</td>
</tr>
<tr>
<td>Future land use</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
</tr>
<tr>
<td>Population around the route</td>
<td>moderate</td>
<td>moderate</td>
<td>medium</td>
<td>light to medium</td>
<td>light</td>
<td>light</td>
<td>light</td>
</tr>
<tr>
<td>Public perspective</td>
<td>moderate</td>
<td>moderate</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
<td>difficult</td>
</tr>
<tr>
<td>Step before the tracks</td>
<td>difficult</td>
<td>n/a (easy)</td>
<td>difficult</td>
<td>difficult</td>
<td>moderate</td>
<td>moderate</td>
<td>n/a (easy)</td>
</tr>
<tr>
<td>Less than 1 mile out of direction</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Completed</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Emergency Hazardous Material response capabilities</td>
<td>difficult</td>
<td>difficult</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
<td>moderate</td>
</tr>
<tr>
<td>Site within jurisdiction</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

**Figure 2** - Phase 1 Evaluation Matrix

**Railroad Interaction**

The matrix presents the number of CRT crossings and number of CRT tracks. Based on conditions along the Havana route, it was suggested that a similar pair of evaluation
criterion for LRT tracks be added, and the group accepted this recommendation. The study team added the LRT crossing number and track count to the Phase 1 evaluation criteria. The routes without CRT crossings (and hence 0 CRT tracks) were highlighted as 'best'.

The matrix presents the number of freight crossings and number of freight tracks. A discussion of the freight spur crossings along the Sable Blvd route occurred, and the study team agreed to leave the 5 crossings and 6 tracks as shown. The routes without freight crossings (and hence 0 freight tracks) were highlighted as 'best'.

The matrix presents two vehicular storage distances, with some routes showing a dash where storage distance is not a concern (no crossings entirely and/or no adjacent tracks/signals). The routes where storage distance is not a concern were highlighted as 'best'.

Roadway Operations
The matrix presents the number of traffic signals along each route. The term 'key' was discussed, and it was agreed that all signals along each route should be included. The study team confirmed the traffic signal count for each route. After this confirmation, the route(s) with the fewest traffic signals (currently Airport Blvd) were highlighted as 'best'.

The matrix presents the number of roundabouts along each route, and routes without roundabouts were highlighted as 'best'.

The matrix presents information regarding lane widths and turning movements / design vehicles. Based on discussion during the meeting, these criteria were moved to the Phase 2 evaluation.

A discussion of the directionality of the routes occurred as a result of the conversation about the turning movement criterion. The study team was asked if the criteria were being evaluated for trips leaving the facilities along Smith Road, for trips arriving at those facilities, or for both directions of travel. The stakeholders team agreed that directionality was not well evaluated, and that both directions need to be considered. The study team revisited the criteria and applied them to both directions of travel.

The matrix presents a generic assessment of the vertical roadway alignment along each route. The routes with an easy vertical alignment were highlighted as 'best'.

The matrix presents a travel distance between Magellan and the midpoint of the interchange at the other end of the route. The stakeholder team noted that travel distance should also include distance along the interstate. The study team revisited the distance measurement to account for this. Using the existing values in the matrix, the routes with a distance of less than 2 miles were highlighted as 'best'.

A discussion of pedestrian access and possible issues with pedestrians occurred. The study team added pedestrian facilities and issues to the Phase 1 evaluation criteria.
Freeway Operations
The matrix presents a generic assessment of the merge distance at the freeway end of each route. The routes with an easy merge were highlighted as 'best'.

The matrix presents the interchange configuration at the freeway end of each route. The stakeholder team discussed that a direct ramp provides the best access. However, the only interchange with a direct ramp configuration only provides connections to/from the east on I-70, so no routes were highlighted as 'best'. Aurora also noted that the Colfax / I-225 interchange is a double diamond configuration (two northbound exit ramps / two southbound entrance ramps) shared with 17th Street.

The matrix presents a generic assessment of the vertical freeway alignment along each route. The routes with an easy vertical alignment were highlighted as 'best'.

Communities
The matrix presents a generic assessment of adjacent land use. The stakeholder team discussed whether this was existing land use or future land use, and the study team responded that this criterion was based on existing land use. The stakeholder team recommended that future land use be considered as well. Aurora noted planned developments along the south side of Colfax west of Chambers and near the Colfax / I-225 interchange. The study team added future land use to the Phase 1 evaluation criteria. The routes in industrial areas were highlighted as 'best'.

The matrix presents a generic assessment of population along each route. The routes with light population were highlighted as 'best'.

The matrix presents a generic assessment of the public perspective of added trucks along each route. The routes with an easy public perspective were highlighted as 'best'.

Jurisdictions and Agencies
The matrix presents a generic assessment of consistency with laws and regulations. Aurora noted that most major City arterials are included in the City's through truck routes and can be used for hazmat travel as part of destination routing, subject to City Code requirements for routing and City oversize/overweight transport permit requirements. They reiterated that they do not specifically permit any hazardous material shipments. There was a discussion of the statute language, which directs carriers to minimize the distance traveled outside of designated routes while maintaining safety. After discussion with the stakeholders, the study team agreed to further evaluate this language and develop a more detailed evaluation criterion for use in the Phase 2 evaluation.

The matrix presents a generic assessment of emergency response capabilities. The stakeholder team discussed this topic and agreed that locations where more than one jurisdiction could have primary response duties would rank poorly. This includes
Denver (to the west) and various smaller fire departments to the east of Himalaya Road. The routes with easy response capabilities were highlighted as 'best'.

The matrix presents an assessment of the number of jurisdictions along each route. The routes that remain within one jurisdiction were highlighted as 'best'.

The study team opened a discussion of the final Phase 1 evaluation matrix that was distributed prior to the meeting. The only comment received was a discussion of freeway operations at Airport Blvd and Tower Road. The stakeholder group concluded that both Airport Blvd and Tower Road should reflect a 'moderate' ranking due to the westbound on ramp alignment at Airport Blvd and the short eastbound merging movement at Tower Road. This resulted in a lowering of the Tower Road overall score from 14 to 13. This route still has the highest Phase 1 score of the routes examined.

The stakeholder team also noted that the study team looked at criteria that apply in one direction versus both directions per discussion at the previous stakeholder meeting. Both the final Phase 1 matrix and the draft Phase 2 matrix have been updated to include "inbound only" or "outbound only" text for those criteria that only reflect inbound or outbound movements.

Phase 1 Results

The study team summarized the number of 'best' rankings for each alternate route, based on the information available at the meeting. The routes that received the most 'best' rankings were Airport Blvd, Colfax to I-225, and Tower Road.

The stakeholder team discussed the conclusions. Based on the re-evaluation of travel distance described above, it was assumed that Colfax to I-225 would score at least one fewer 'best' ratings, and would drop off once the Phase 1 re-evaluation was completed. Hence, the stakeholders agreed that Airport Blvd and Tower Road should move into Phase two screening. Chambers Road was also included in the Phase 2 screening as it is the current route.

The study team addressed the comments on the Phase 1 criteria above and revised the Phase 1 evaluation matrix accordingly. A final Phase 1 matrix was distributed, and the routes scoring the highest (anticipated to be Airport Boulevard and Tower Road) passed on to Phase 2 screening.

The study team reviewed each of the potential routes and identified key features. The study team applied the Phase 1 evaluation criteria to the eight potential routes and summarized the results in a matrix. The resulting matrix was distributed prior to the second stakeholder meeting.

The stakeholders reviewed the eight potential routes using the Phase 1 evaluation criteria at the meeting. At the end of the meeting, the stakeholders agreed on the top two alternate routes (Airport Blvd and Tower Road) to be evaluated with the Phase 2
criteria. As the existing route, Chambers was also forwarded into the Phase 2 evaluation.

The study team evaluated the selected routes using the Phase 2 criteria and distribute a draft evaluation before the next Stakeholder meeting.

Phase 2 Evaluation

The study team moved to the Phase 2 evaluation matrix, and projected a copy on the screen for live editing. For each criterion, the study team selected the 'best' result and highlighted those results in the matrix. Figure 3 shows the phase 2 evaluation matrix.

The stakeholder team asked about shoulders along the roadways under study. The shoulders along Smith Road are generally consistent throughout the study are and are not a discriminator. Airport Blvd and Tower Road are typically curbed sections, and do not have shoulders.
<table>
<thead>
<tr>
<th>Feature</th>
<th>Chambers Road</th>
<th>Airport/Expressway</th>
<th>Town Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of at-grade CRI rail crossings &amp; number of CRI tracks</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of at-grade LRT crossings &amp; number of LRT tracks</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of at-grade freight rail crossings &amp; number of freight tracks</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total rail crossings</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Storage distance between tracks (feet)</td>
<td>6</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Storage distance between tracks and adjacent signal (feet only)</td>
<td>25'</td>
<td>90'</td>
<td>100'</td>
</tr>
<tr>
<td>Traffic signals</td>
<td>5</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Roundabouts</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pedestrian facilities</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Vertical alignment</td>
<td>easy</td>
<td>moderate</td>
<td>easy</td>
</tr>
<tr>
<td>To I-70 and I-70</td>
<td>4.8 miles</td>
<td>6.9 miles</td>
<td>8.5 miles</td>
</tr>
<tr>
<td>To I-70 and Colfax</td>
<td>5.8 miles</td>
<td>5.5 miles</td>
<td>5.2 miles</td>
</tr>
<tr>
<td>To I-255 and Colfax</td>
<td>4.1 miles</td>
<td>6.3 miles</td>
<td>7.9 miles</td>
</tr>
<tr>
<td>Total</td>
<td>14.7 miles</td>
<td>18.7 miles</td>
<td>21.6 miles</td>
</tr>
<tr>
<td>Adequate Lane Widths</td>
<td>2'11&quot;</td>
<td>1'7&quot;</td>
<td>1'5&quot;</td>
</tr>
<tr>
<td>Adequate turning movements / design vehicle</td>
<td>Yes</td>
<td>Improvement needed (should)</td>
<td>Yes</td>
</tr>
<tr>
<td>Overall crash history at intersections</td>
<td>2.2</td>
<td>1.6</td>
<td>1.0</td>
</tr>
<tr>
<td>Commercial vehicle crashes</td>
<td>6</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Large trucks</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Protected</td>
<td>EB Smith to NB Chambers</td>
<td>EB Smith to NB Tower</td>
<td></td>
</tr>
<tr>
<td>Adequate storage distance (feet only)</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Remaining the same</td>
<td>40 extra trucks per hour</td>
<td>40 extra trucks per hour</td>
<td></td>
</tr>
<tr>
<td>Pavement condition</td>
<td>asphalt, four</td>
<td>asphalt and concrete, four</td>
<td>asphalt, four</td>
</tr>
<tr>
<td>Road capacity</td>
<td>305,128 yd2</td>
<td>42,227 yd2</td>
<td>4,222,173 yd2</td>
</tr>
<tr>
<td>Future</td>
<td>305,128 yd2</td>
<td>42,227 yd2</td>
<td>4,222,173 yd2</td>
</tr>
<tr>
<td>Future H/4</td>
<td>4,222,173 yd2</td>
<td>4,222,173 yd2</td>
<td>4,222,173 yd2</td>
</tr>
<tr>
<td>Improvements required</td>
<td>Increase storage for EB from at Smith and Chambers</td>
<td>Improve signalization at Smith/Airport: Improve signalization at I/70 interchange: Improve curb cuts at at Smith at Airport</td>
<td></td>
</tr>
<tr>
<td>Conceptual costs</td>
<td>55,000</td>
<td>$300,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>Adequate roadway right on interstate (feet only)</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Intersection configuration</td>
<td>diamond</td>
<td>partial cloverleaf</td>
<td>diamond</td>
</tr>
<tr>
<td>Vertical and horizontal alignment</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
</tr>
<tr>
<td>Pavement condition</td>
<td>concrete, four</td>
<td>concrete and asphalt, four</td>
<td>asphalt, four</td>
</tr>
<tr>
<td>Highway capacity</td>
<td>186,000 yd2</td>
<td>78,000 yd2</td>
<td>61,900 yd2</td>
</tr>
<tr>
<td>Heavy vehicle capacity</td>
<td>186,000 yd2</td>
<td>78,000 yd2</td>
<td>61,900 yd2</td>
</tr>
<tr>
<td>Future H/4</td>
<td>61,900 yd2</td>
<td>61,900 yd2</td>
<td>61,900 yd2</td>
</tr>
<tr>
<td>Improvements required</td>
<td>Adjust super NB ramp on ramp: EB in middle lengths: Improve length: Improve lengths</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conceptual costs</td>
<td>$50,000,000</td>
<td>$500,000</td>
<td>$500,000</td>
</tr>
<tr>
<td>Adjacent land use</td>
<td>Industrial</td>
<td>Industrial</td>
<td>Industrial</td>
</tr>
<tr>
<td>Future land use</td>
<td>light</td>
<td>light</td>
<td>light</td>
</tr>
<tr>
<td>Pavement along the route</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
</tr>
<tr>
<td>Sensitive areas</td>
<td>Sand Creek, Star K Ranches, west branch of Naples Canal</td>
<td>Sand Creek, Star K Ranches, west branch of Naples Canal</td>
<td>Sand Creek, Star K Ranches, west branch of Naples Canal</td>
</tr>
<tr>
<td>Adjacent airports</td>
<td>easy</td>
<td>easy</td>
<td>easy</td>
</tr>
<tr>
<td>Improvements required</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

*Figure 3 - Phase 2 Evaluation Matrix*
**Railroad Interaction**

There were no changes in this section from Phase 1.

**Roadway Operations**

The Phase 1 results were typically unchanged in the Phase 2 evaluation, so only the Phase 2 criteria were discussed in depth.

The matrix presents the number of traffic signals along each route. The stakeholder team noted that a new signal is programmed to be constructed on Tower Road at E 28th Avenue. Since this will affect the route in the future, the stakeholder team agreed to update the number of traffic signals for Tower Road in the matrix.

Information regarding lane widths is shown in the matrix. The data represent averages along the overall route, and were obtained from available aerial imagery. Airport Blvd was found to have the most 12' lanes, and was ranked the best.

The turning movements / design vehicles category indicated that truck turning movements are generally accommodated except for the southbound Airport Blvd to westbound Smith Road right turn. Hence, Chambers Road and Tower Road were marked as best.

The matrix presents three crash history criteria that generated a significant discussion. The stakeholder team noted that designation of a formal hazmat route will require a full safety analysis. The stakeholder team concluded that this is beyond the scope of the alternate route selection study. The stakeholder team noted that constituents report that the highest number of commercial vehicle collisions along the Phase 2 routes are at the Airport / I-70 interchange. However, the stakeholder team noted that this is not a rate, and therefore not statistically significant. The stakeholder team further noted that doing a crash study requires pulling each individual crash report. This is because collision database coding is often not detailed enough to confirm the actual collision location without reading the reports themselves. The stakeholders concluded that it is not appropriate for the alternatives study to go to this level of effort. The stakeholder team noted that the City does an annual city-wide review of high accident intersections using a safety measure known as LOSS. In the most recent year of this study, seven intersections out of 330 locations city-wide reflected a LOSS of three or more, indicating safety concerns. None of these intersections are along the Phase 2 routes. The stakeholder team then suggested that a detailed crash analysis be a subsequent analysis only if one alternative does not rise to the top during the Phase 2 evaluation. The stakeholder team objected to this approach, stating that safety is crucial component of the routing study and needs to be examined as part of the Phase 2 evaluation. The stakeholder further proposed a two-step solution: The City provided LOSS data for the intersections along the Phase 2 routes from the latest city-wide safety study.

The stakeholder team worked with Aurora FD to obtain a list of Aurora FD collision responses related to commercial and hazmat vehicles along the Phase 2 routes.
Although this list did not provide collision rates, it did provide a snapshot of areas where commercial vehicle and hazmat collisions are occurring.

The stakeholders agreed that this reflects a reasonable approach for this study. The study team worked with the City of Aurora to complete this effort.

The matrix presents information regarding left turn movement type. The stakeholder team were unclear about this criterion. The study team described the differences between protected, protected-permitted, and permitted left turns. The study team further described that each left turn on the outbound route was evaluated and the number of each type along each route was entered into the matrix. Left turns along the inbound routes were all observed to be protected, so the inbound direction is not a discriminator. Airport Blvd is the only route with a permitted-only left turn, so the remaining routes were ranked as ‘best’. For clarity, the study team updated which movements are located at the intersections along the routes in the matrix.

The matrix presents a generic assessment of the outbound left turn storage distance. Airport Blvd was identified as the only route with adequate storage lengths, and was marked as best. As with the left turn movement type, the inbound direction has adequate storage distance for all routes, and is not a discriminator.

The matrix presents an assessment of queuing and pavement conditions. No discriminators were found.

The matrix presents information regarding roadway capacity and heavy vehicle capacity. A representative ADT was selected for each route, and the ADT was divided by the number of lanes and multiplied by 10% to represent peak hour volumes. The peak hour volumes were compared to a 1,000 vehicle per hour threshold (obtained from the Highway Capacity Manual) to determine if the route was above or below capacity. All of the routes were found to be below capacity. Then, 1,000 heavy vehicles were added to the daily number and the math was repeated to develop a future capacity evaluation. All routes were found to be below capacity with the addition of the truck traffic. To further evaluate the potential impacts of heavy vehicles, the 1,000 daily trucks were multiplied by a passenger car equivalent factor (also based on the Highway Capacity Manual) to account for the slower and longer trucks in the traffic stream. Again, the capacity calculations were performed and all routes were found to be below capacity with the addition of the truck passenger car equivalents. Also, existing percent heavy vehicles in the traffic stream were obtained (where available) and recalculated based on the addition of 1,000 daily trucks. No significant changes were noted. None of these measures were found to be discriminators between the routes.

Based on the roadway shortfalls identified in the matrix, potential improvements were identified for each of the Phase 2 routes. These were further developed based on the input above, the results of the crash analysis and other matrix updates, and additional concept engineering. The potential improvements were incorporated into the final report.
Freeway Operations
The updates to the Phase 1 merge distance criterion were incorporated into the Phase 2 table.

The matrix presents a generic assessment of the pavement conditions. No discriminators were found.

The matrix presents the interstate capacity and heavy vehicle capacity for the routes. The calculations are the same as those for the roadway operations, except that a freeway capacity of 1,900 vehicles per hour (from the Highway Capacity Manual) was used in the freeway equations. The existing traffic volumes for each route were taken from CDOT’s OTIS online traffic database at a location just west of the route’s interchange with I-70. The segment just west of Airport Blvd was identified to be just over capacity. Based on discussions with the stakeholders, the study team evaluated what improvements (if any) the Central 70 project were making in this area, and updated the matrix accordingly. The routes with a yes were highlighted as “best”.

Based on the freeway shortfalls identified in the matrix, potential improvements were identified for each of the Phase 2 routes. These were further developed based on the input above, the results of the crash analysis and other matrix updates, and additional concept engineering. The potential improvements were incorporated into the final report.

Communities
For Phase 2, the matrix presents a generic assessment of sensitive areas. Sensitive areas are schools, lakes, rivers, etc. that have environmentally and population based safety concerns. These generally increase as you move east in the study area, and Chambers Road was identified as the best alternative.

Jurisdictions and Agencies

No changes were made from Phase 1.

Phase 2 Results

The study team addressed the stakeholder comments on the Phase 2 criteria above and revise the Phase 2 evaluation matrix accordingly to be included in this report. A final Phase 2 matrix was distributed, and the routes in Phase 2 are described further in this report.

CMCA noted that they would like to see a slow transition to any new route as to not overwhelm the system and the public.
Final Alternative Refinement

Recommendations
In conclusion of going through the two phase process outlined above in this report, the recommendations for a preferred route and route improvements are outlined below. Upon completion of stakeholder review and comments on this report, the study team will update and a final report will be issued.

Preferred Route
The Phase 2 evaluation provided equivalent scores for both Airport Blvd and Tower Road and a lower score at Chambers Road. Chambers Road was not considered because the purpose of the study was to determine an alternative route to Chambers Road that decreases the chance of hazardous material vehicle and rail interaction while providing a safe and reliable route. With Airport Blvd and Tower Road ranking the same, see Figure 3, the study team considers Airport Blvd as the preferred route since it provides the safest and most direct route and adheres to Federal and State hazardous material routing statutes. The southbound hazardous material trucks from I-70 should continue to use Chambers Road to access the trucking facility for consistency with existing truck operations. There are no safety concerns with the southbound hazardous material truck movements stopping on the tracks or blocking the intersection. They do not pose unsafe and unexpected driving conditions. The northbound hazardous material trucks should use Airport Blvd to the east to access I-70.

Route Improvements
Upon selection of the preferred alternative route, Airport Blvd, the study team further analyzed improvements that may be necessary with the introduction of these hazardous material truck routes along Airport Blvd.

The study team has identified the following roadway and traffic signal improvements that may need to be considered for the northbound truck routes to utilize the preferred alternative route:

1) Installing a protected-permissive eastbound to northbound left turn movement by completing signal modifications to the existing traffic signal at the intersection of Airport Blvd and Smith Road. The study team recommends the protected-permissive signal head to allow for the safe protected movement (a green arrow) for left turners and the additional option to turn without the green arrow. This would potentially decrease the number of conflicts.

2) Improvements on the westbound Airport/I-70 on ramp, such as weave distance, superelevation, and general geometry of the ramp should be further evaluated and coordinated with CDOT.